



Supporting TRMM and GPM Applications

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November 13, 2013

2013 GPM Applications Workshop
College Park, Maryland



Discussion

- Data Access and Visualization Tools
- Applications Projects



Goddard Earth Sciences Data and Information Services Center

- One of EOSDIS* Science Data Centers
- Archive, Distribute and Support Usage of Remote Sensing Data and Related Models
 - Hydrology
 - Atmospheric Composition
- Value-added Data Products and Services

*Earth Observing System Data and Information System



Services for Users

- Search and Access (Mirador)
- Subsetting
- Reformatting
- Online Visualization and Analysis (Giovanni)
- Documentation
- Help Desk



Search + Access

- Mirador Search
- Access
 - FTP / HTTP
 - OPeNDAP
 - WMS

Search GES DISC with Keywords in Mirador

Keyword

Keyword: 3B42

Time Span: 2002-01-01



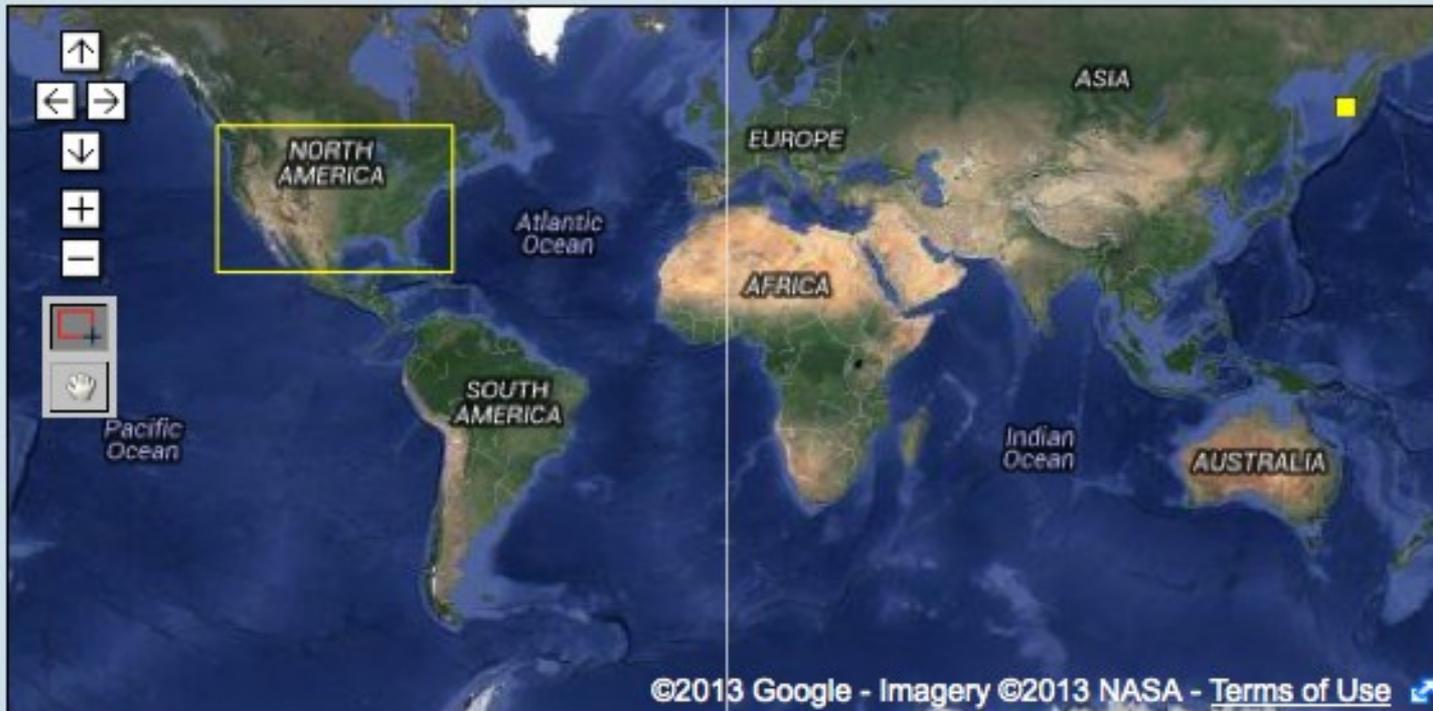
To: 2002-01-31



Location: (22.26,-128.05),(51.39,-68.99)

Update Map

Search GES-DISC



Advanced Search ▾



Data Set Listing for Search

Data Sets

 -More Services (e.g. http download, format conversion, subsets etc) are available for the data set(s). Whenever you click on a gear icon, you will see a list of available services and service parameters for any data set which has these services.

Daily TRMM and Others Rainfall Estimate (3B42 V7 derived) (TRMM_3B42_daily) 

View Files: [All](#) | [006](#) | [007](#) **Info:** [006](#) | [007](#) **Giovanni_Analysis:** [006](#) | [007](#) **Data Calendar:** [006](#) | [007](#)

Approx. 64 files found (Avg Size: 2.197 MB)

Parameters: PRECIPITATION RATE

Spatial Resolution: 0.25 degree x 0.25 degree

Temporal Resolution: Daily

TRMM 3-Hourly 0.25 deg. TRMM and Others Rainfall Estimate Data (TRMM_3B42) 

File List for Search

Daily TRMM and Others Rainfall Estimate (3B42 V7 derived) [Info](#)

The following services are available for the data set(s). Whenever you add files to the shopping cart, y

 [Convert to NetCDF](#)  [Convert to gzipped NetCDF](#)

Add Selected Files To Cart

Add All Files in All Pages To Cart

Select All in Page **File Names/Descriptive File Names**

[3B42_daily.2002.02.01.7.bin](#) (2.20 MB)

One Click Download: [BIN \(FTP\)](#) | [NetCDF](#) | [OPeNDAP](#)

[3B42_daily.2002.01.31.7.bin](#) (2.20 MB)

One Click Download: [BIN \(FTP\)](#) | [NetCDF](#) | [OPeNDAP](#)

[3B42_daily.2002.01.30.7.bin](#) (2.20 MB)

One Click Download: [BIN \(FTP\)](#) | [NetCDF](#) | [OPeNDAP](#)

[3B42_daily.2002.01.29.7.bin](#) (2.20 MB)

One Click Download: [BIN \(FTP\)](#) | [NetCDF](#) | [OPeNDAP](#)

[3B42_daily.2002.01.28.7.bin](#) (2.20 MB)

One Click Download: [BIN \(FTP\)](#) | [NetCDF](#) | [OPeNDAP](#)

[3B42_daily.2002.01.27.7.bin](#) (2.20 MB)

One Click Download: [BIN \(FTP\)](#) | [NetCDF](#) | [OPeNDAP](#)



Drill down by Project

Keyword

Projects

Science Areas

is designed to monitor and study tropical rainfall



Drill down by Project

Keyword Projects Science Areas

TRMM

The Tropical Rainfall Measuring Mission (TRMM) is a joint endeavor between NASA and Japan's National Space Development Agency. It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation, shaping both global weather and climate.

Data Group	Description	Date Range
Ancillary (1)	TRMM Ancillary data products	2000-02-07 to 2013-11-04
Climatology (12)	TRMM Composite Climatology (TCC) consists of a merger of selected TRMM rainfall products over both land and ocean to give a "TRMM-best. climatological estimate. Inputs to the composite were selected based on knowledge of the performance of the retrievals, limitations of the algorithms, and the presence of artifacts.	1998-01-01 to 2010-05-31
Gridded (22)	Gridded data products from VIRS, TMI, and PR, at a range of spatial and temporal resolutions	1997-12-01 to 2013-11-04
Ground-based Instrument (15)	Ground-based instrument data products	1995-01-03 to 2013-10-31
Orbital (13)	Orbital data products from VIRS, TMI, and PR, at the sensor's resolution	1997-12-07 to 2013-11-04
Subset (23)	Parameter, gridded, regional gridded, and coincidence subset data derived from TRMM standard data products	1993-01-01 to 2013-11-04



Drill down by Science Area

Keyword

Projects

Science Areas

er budget at global and regional scales.

[Upward Longwave Flux \(1\)](#)



Drill down by Science Area

Water and Energy Cycles

Through water and energy cycle research we can improve hurricane prediction, quantify tropical rainfall and eventually

Atmospheric Radiation (12)

The process by which electromagnetic radiation is propagated through free space.

Downward Shortwave Flux (4)

Upward Shortwave Flux (2)

Clouds (67)

A visible aggregate of minute water droplets and/or ice crystals in the Earth's atmosphere.

Cloud Condensation Nuclei (3)

Cloud Ice Water (11)

Cloud Particle Phase (4)

Heat Flux (23)

Heat flux is the amount of heat that is transferred across a surface of unit area in a unit of time. Also refers to latent and sensible heat fluxes in the atmosphere and between the Earth's surface and atmosphere.

Downward Heat Flux (1)

Heat Diffusivity (1)

Latent Heat Flux (positive



Drill down from Science Area to Measurement

Precipitation (115)

Any or all of the forms of water droplets, whether liquid or solid, that fall from clouds and reach the ground.

Anvil Precipitation (1)

Cloud Ice Water (11)

Cloud Water Path (3)

Ice Flux (1)

Precipitable Water (14)

Precipitation Rate (25)

Rainfall Rate (34)

Total Re-evaporation of Precipitation (1)

Total Surface Precipitation (1)

Atmospheric Water Vapor (63)

Cloud Liquid (1)

Convective Precipitation (1)

Large-scale Precipitation (1)

Precipitation Flux (1)

Rain Flux (1)

Snowfall Rate (20)

Water Vapor Conversion (1)

Cloud Ice (3)

Cloud Liquid Water (22)

Frozen Precipitation (1)

Liquid Precipitation (1)

Precipitation Production Rate (1)

Rain Liquid Water (1)

Surface Precipitation Flux (3)



Drill down from Science Area to Measurement

[Anvil Precipitation](#) (1)

[Cloud Ice Water](#) (11)

[Cloud Water Path](#) (3)

[Ice Flux](#) (1)

[Precipitable Water](#) (14)

[Precipitation Rate](#) (25)

[Rainfall Rate](#) (34)

[Total Re-evaporation of Precipitation](#) (1)

[Total Surface Precipitation](#) (1)

[Atmospheric Water Vapor](#) (63)

[Cloud Liquid](#) (1)

[Convective Precipitation](#) (1)

[Large-scale Precipitation](#) (1)

[Precipitation Flux](#) (1)

[Rain Flux](#) (1)

[Snowfall Rate](#) (20)

[Water Vapor](#)



Subsetting and Reformatting

- Subsetting
 - Space, time, variable
 - Shapefile mask: *Future..*
- Reformatting
 - netCDF for almost all data
 - e.g., Importing netCDF Grid Data into ArcGIS
 - KMZ (Google Earth) for some datasets
 - **GeoTIFF: *Coming soon...***



Subsetting with Simple Subset Wizard

SIMPLE SUBSET WIZARD (SSW) [v1.07 RELEASE NOTES](#)

- 1. Search for Data Sets
- 2. Select Subset Criteria
- 3. View Results

Enter values for the Date Range and (optionally) the Spatial Bounding Box to search for data sets; those criteria will also be used when data sets are subsetting by Date Range and Spatial Region.

Enter keywords or click the 'Select Data Sets' button.

Data Set Keyword(s)

3B42

Select Data Sets

Enter dates as YYYY-MM-DD or use the calendars.

Date Range

2001-01-01



to 2001-12-31



Enter South, West, North, East coordinates or use the map.

Spatial Bounding Box

14.06,-120.23,47.11,-69.61



Search for Data

[Report a Problem with the Simple Subset Wizard](#)

71°00'N, 88°35'W

Close

The map displays a satellite-style view of the Earth with a yellow bounding box highlighting a region in the Arctic. The bounding box coordinates are 71°00'N, 88°35'W. The map includes navigation controls: a hand icon for panning, a square icon for zooming, and a vertical stack of arrows for panning. A 'Close' button is located in the bottom right corner of the map window.



Subsetting with Simple Subset Wizard

Found 2 subsettable data sets.

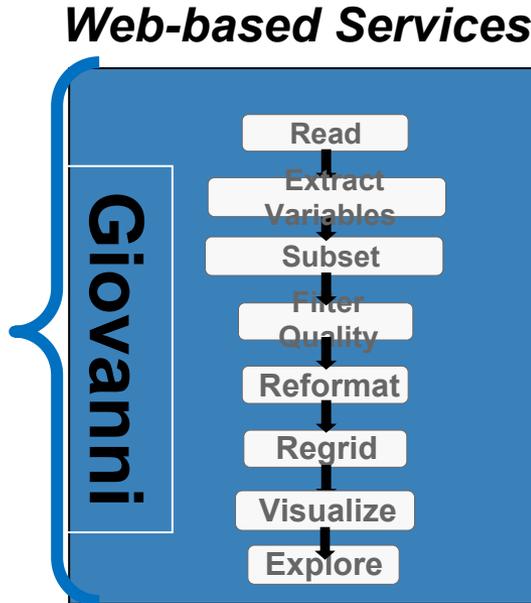
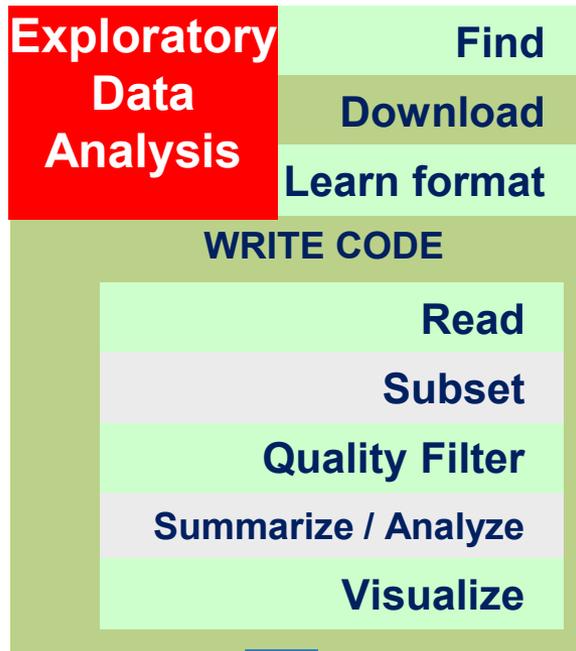
Subset: Spatial Region (14.06,-120.23,47.11,-69.61), Variables for TRMM_3B42 v6 in netCDF

Subset: Spatial Region (14.06,-120.23,47.11,-69.61), Variables for TRMM_3B42 v7 in netCDF

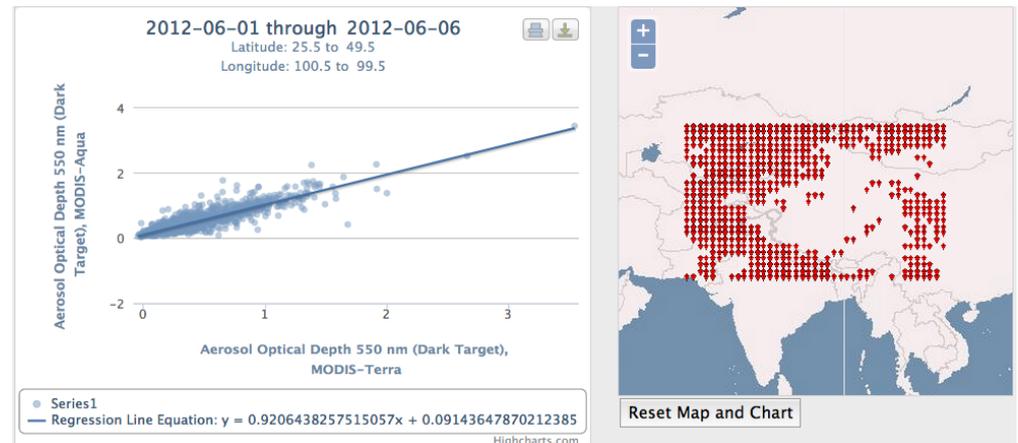
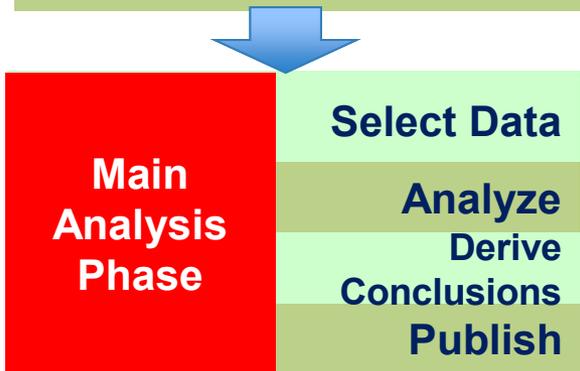
Number of Variables selected=1

- high quality precipitation
- IR precipitation
- precipitation
- relativeError
- satellite observation time
- source

Exploratory Analysis of Remote Sensing Data with Giovanni*



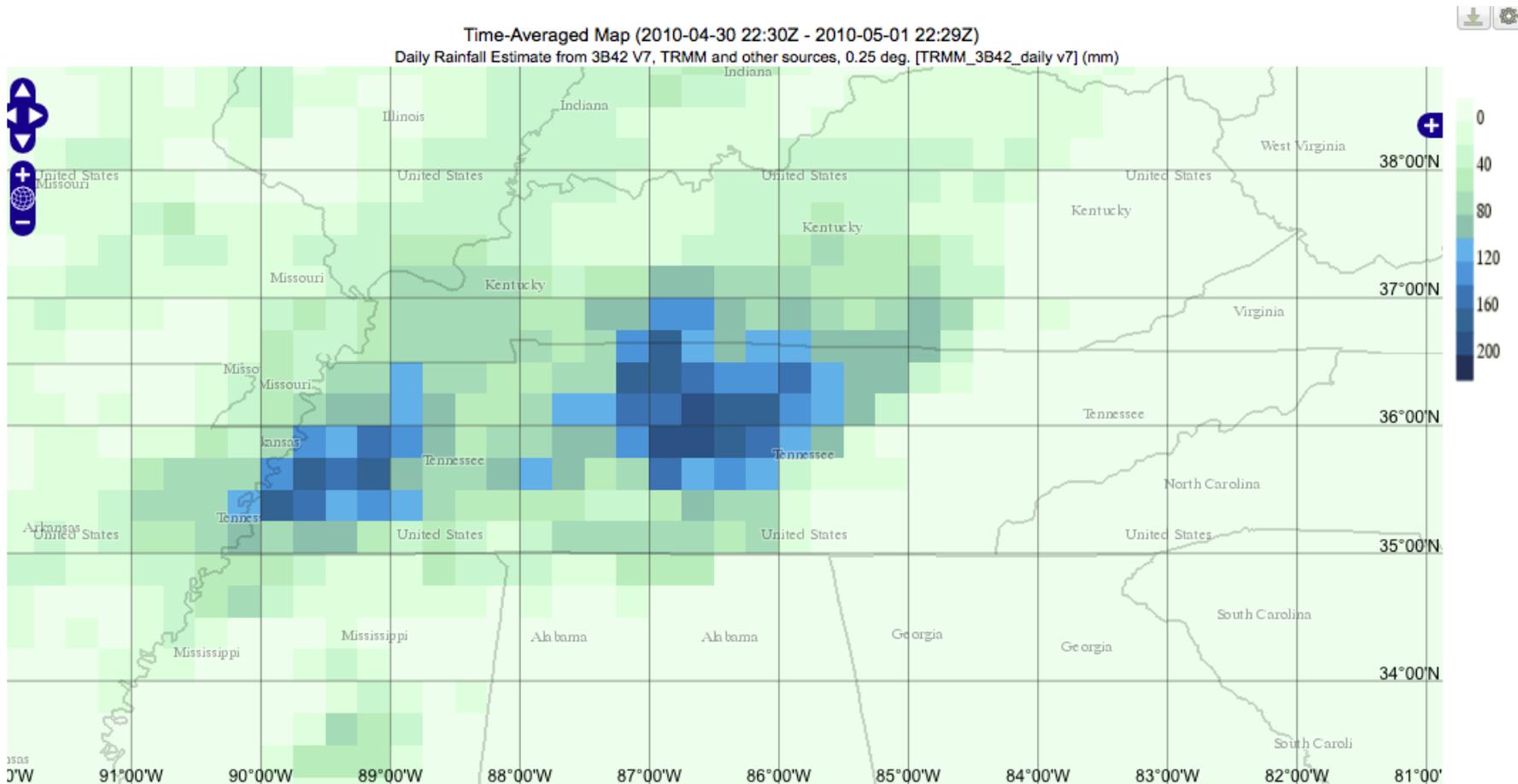
Giovanni provides *Quick-Start Exploratory Data Analysis*:
no coding necessary



linked interactive scatterplot + map



Giovanni Time-Averaged Map

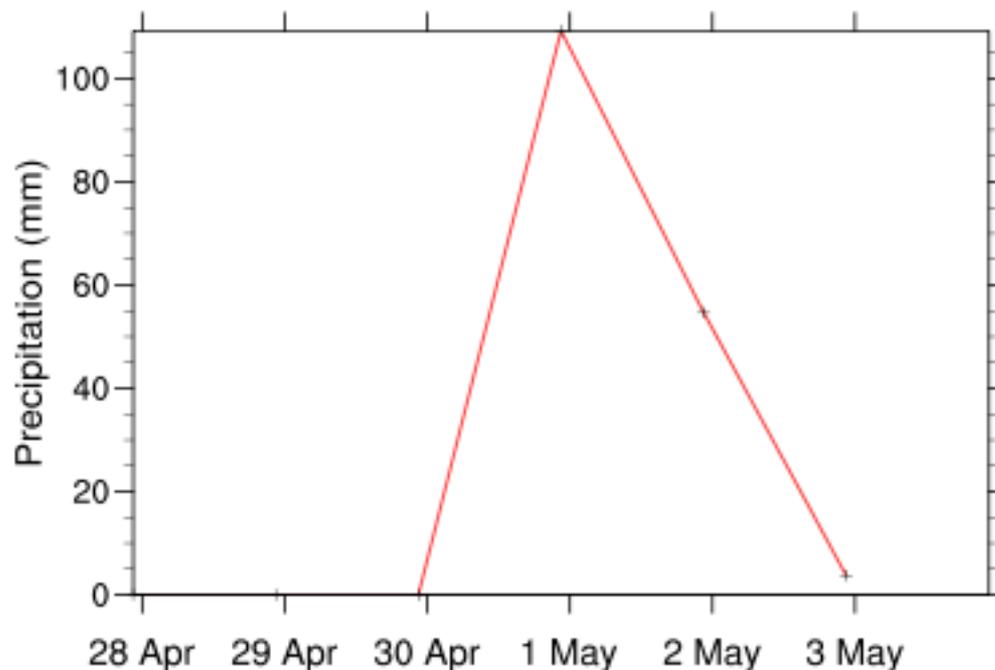


Selected date range was 2010-05-01 - 2010-05-01. Title reflects the date range of the granules that went into making this result



Giovanni Time Series

TRMM_3B42_daily v7 Area-Averaged Time Series
2010-04-27 22:30Z - 2010-05-03 22:29Z, Region 90W, 35N, 86W, 37N



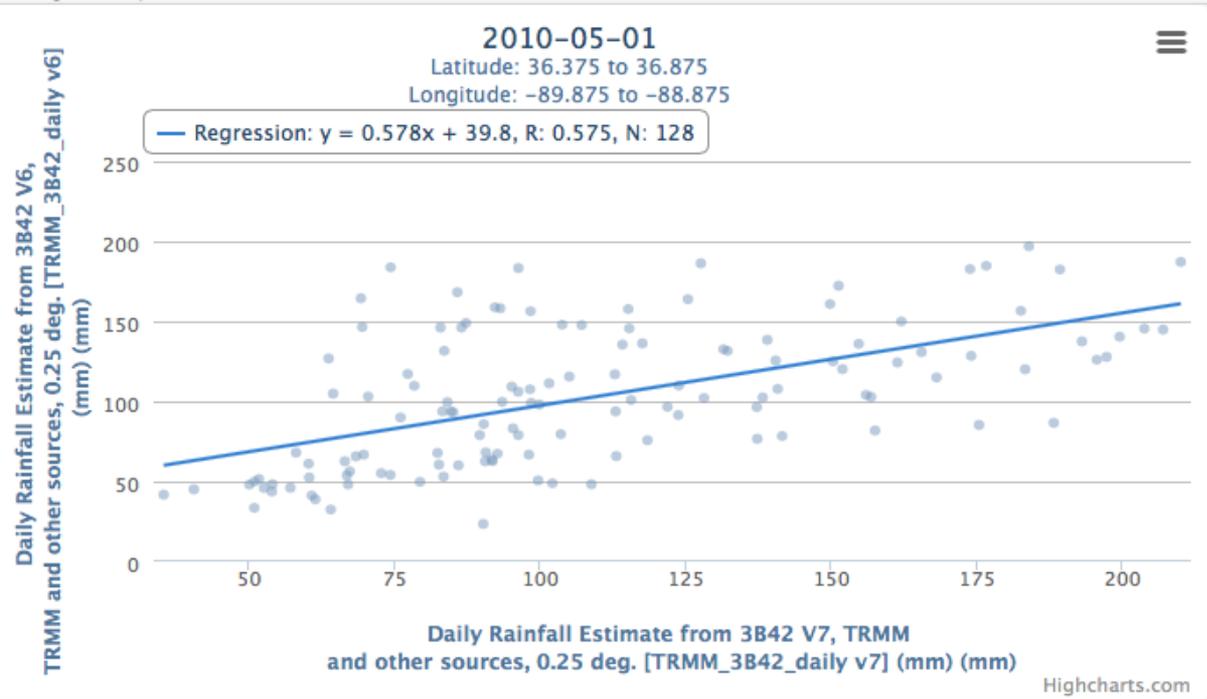
—+— Precipitation: Daily Rainfall Estimate from 3B42 V7, TRMM and other sources, 0.25 deg.



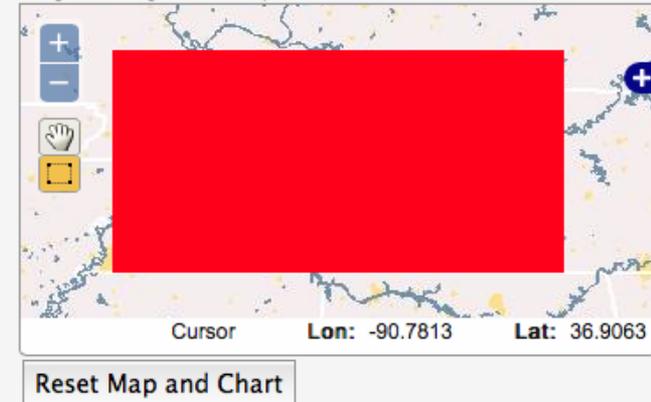
Giovanni Interactive Scatterplot

Interactive Scatter Plot

Drag bounding box on plot to subset data



Drag bounding box on map to subset data



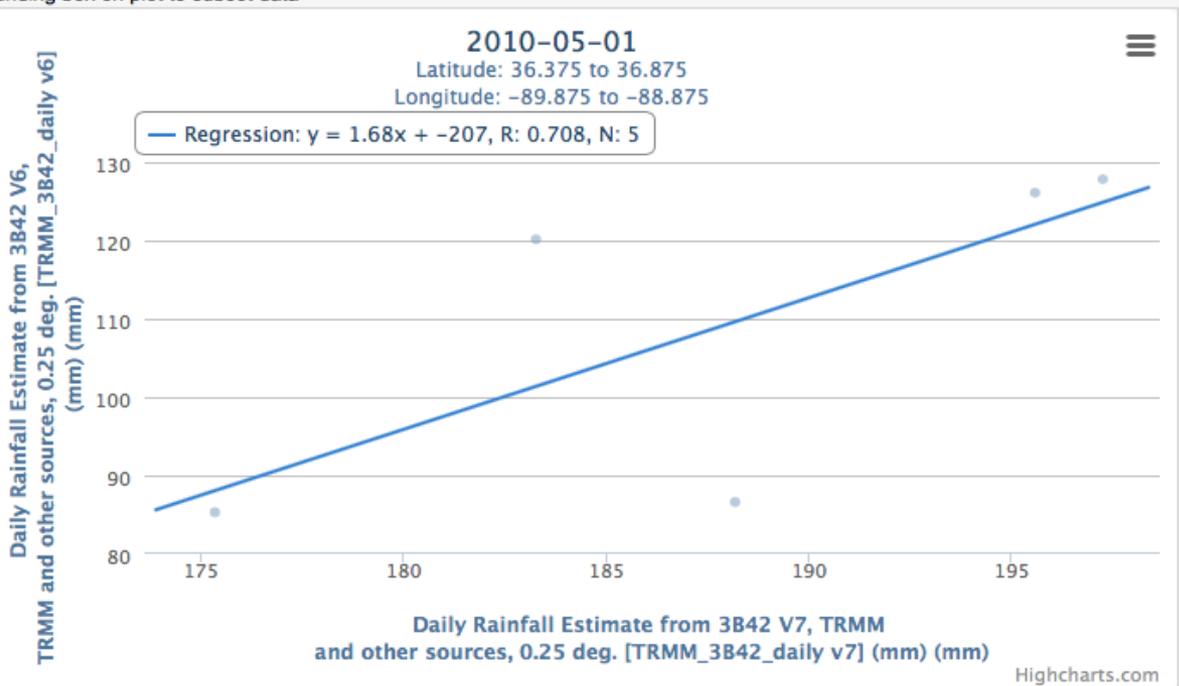


Giovanni Interactive Scatterplot

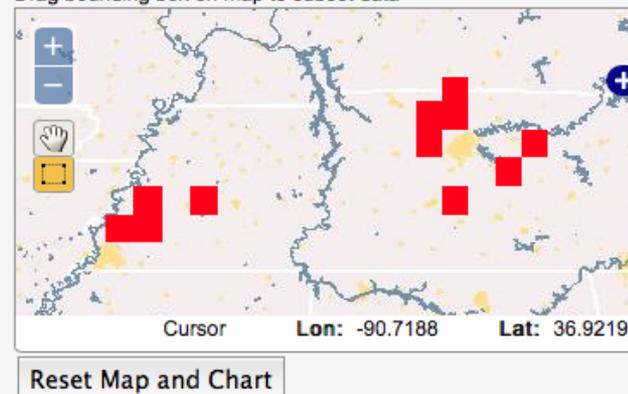
Clicking result to plot

Interactive Scatter Plot

Drag bounding box on plot to subset data



Drag bounding box on map to subset data



Zoom in on Scatterplot



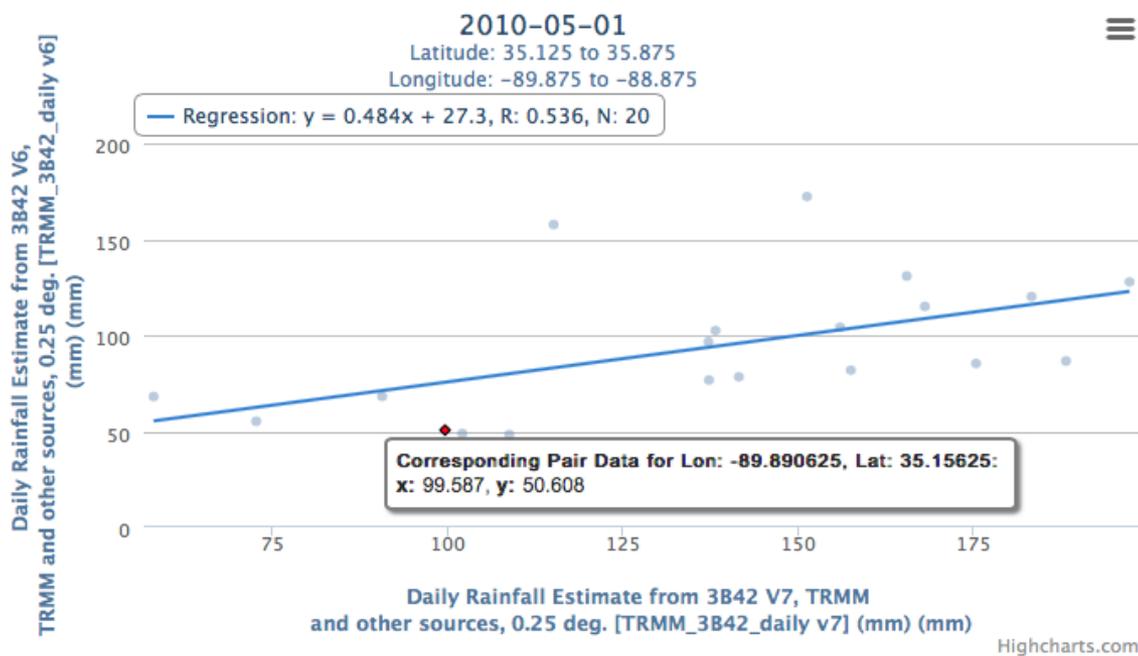
Giovanni Interactive Scatterplot

Warning: One or more of Giovanni's Deep Blue Level 3 variables are no longer available. [1 of 2 messages] [Load More](#)

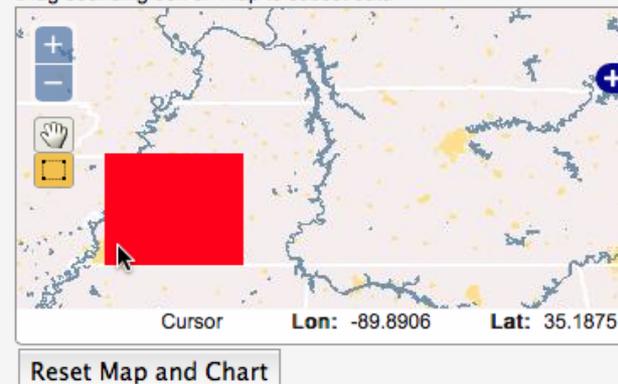
Displaying Result 10 Plots

Interactive Scatter Plot

Drag bounding box on plot to subset data



Drag bounding box on map to subset data



Examine a Subregion

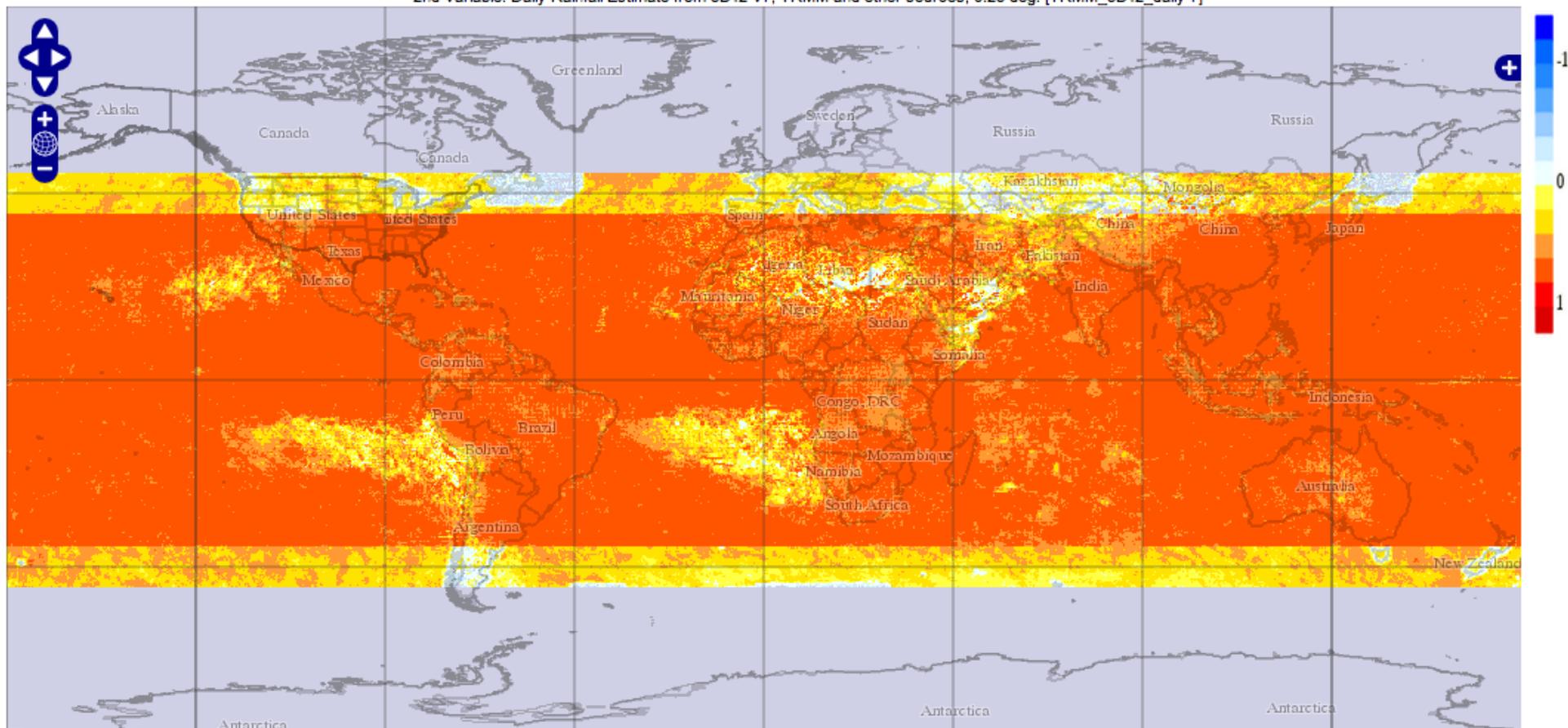


Giovanni Correlation Map

Correlation for 1998-01-01 - 1999-12-31

1st Variable: Daily Rainfall Estimate from 3B42 V6, TRMM and other sources, 0.25 deg. [TRMM_3B42_daily 6]

2nd Variable: Daily Rainfall Estimate from 3B42 V7, TRMM and other sources, 0.25 deg. [TRMM_3B42_daily 7]





Other Giovanni Services

- Vertical Profile
- Hovmoller
- Histograms
- Animation
- Seasonal analysis
- Anomaly relative to climatology
- Map of differences between two variables



User Documentation

- README
- How-To Recipes
 - Step by Step How-To
 - e.g., Importing netCDF Grid Data into ArcGIS
 - ***We take requests for recipes...***



How-To Recipes for Data

Recipe Structure

- Overview
- Best When...
- Task
- Example
- Estimated time to complete procedures
- Procedure
 - Numbered steps
 - Key screenshots
- Discussion
- Tool or Service

*We take requests for
recipes...*



Example Recipe: ArcGIS

How to Import Gridded Data in NetCDF Format into ArcGIS

Overview:

Satellite observation and climate model data become more and more widely used in GIS. A community. NetCDF format is not a traditionally used GIS format although it is getting popular. Import a model or satellite (Level 3 or Level 4) data file in NetCDF format into ArcGIS.

Best When:

The data is in CF-complaint NetCDF format

Task: Viewing Data

Example:

Import a TRMM monthly precipitation data file into ArcGIS.

Estimated time to complete the following procedure: 5 min

Procedure:

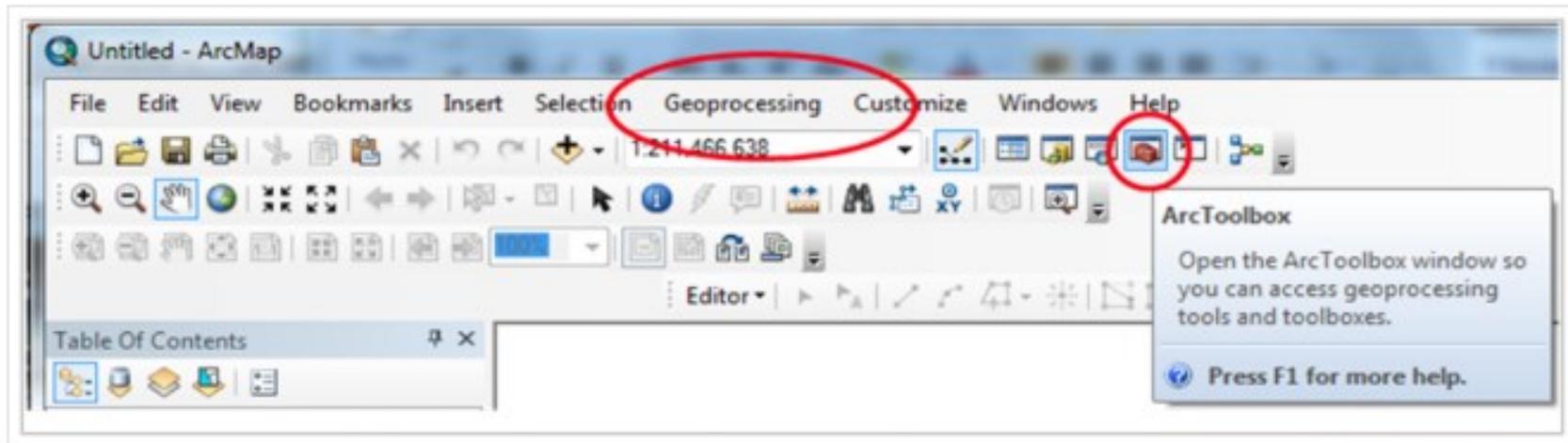
- 1) Getting data in NetCDF format



Example Recipe: ArcGIS

2) Import data into ArcGIS

- Start an ArcGIS Application, for example, **ArcMap**
- Open the **ArcToolbox** window with the Show/Hide ArcToolbox Window button  found on the standard toolbar or ArcToolbox (Figure 1)





Example Recipe: ArcGIS

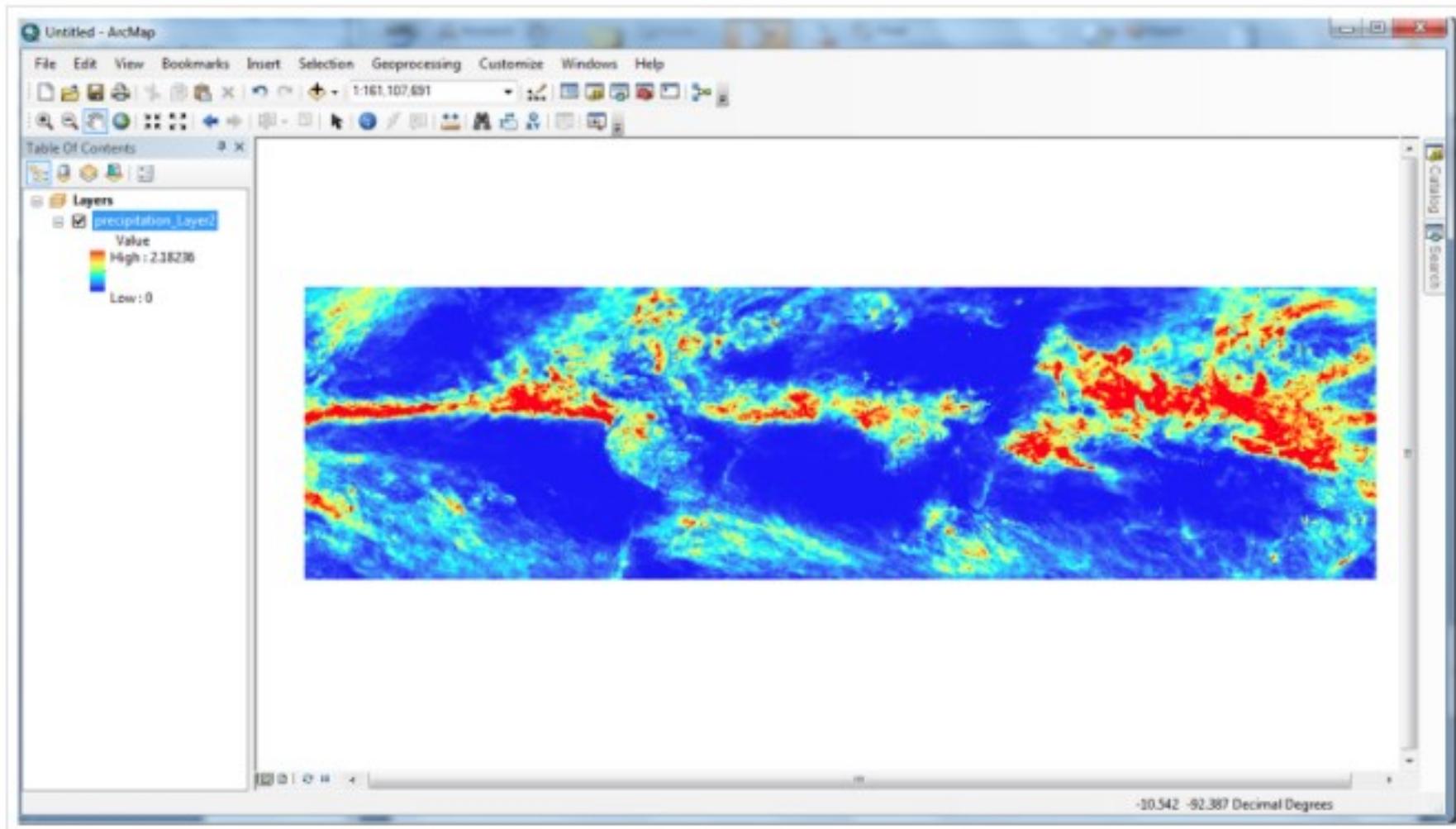
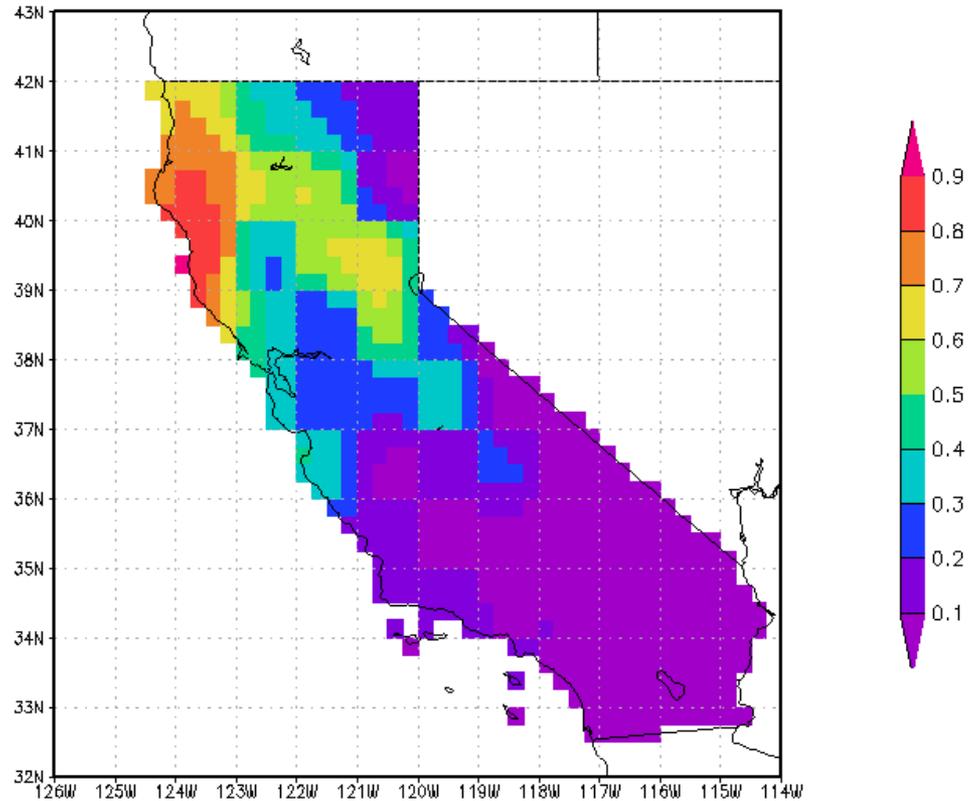


Figure 4: Sample TRMM Level 3 monthly precipitation displayed in ArcMap



Coming Soon: Shapefile Masking

Average Monthly Precipitation Rate from TRMM 3B43



GrADS: COLA/IGES

2013-11-04-18:02

Recipe in testing...



Enhancing Access to NASA Satellite Data by USDA

Work supported by NASA ROSES NNH08ZDA001N-DECISIONS and
CAN-02-OES-01 (REASoN)

Projects with USDA

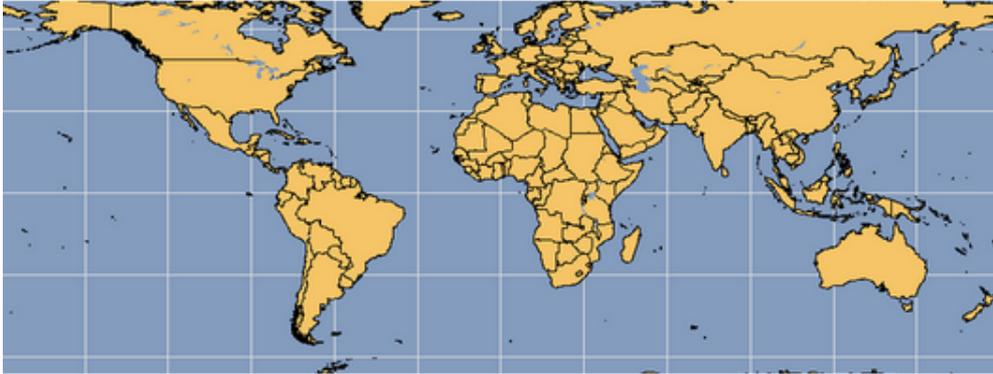
USDA FAS Crop Explorer & TMPA

USDA United States Department of Agriculture
Foreign Agricultural Service

Crop Explorer

Toolbox

Click on map to get **TMPA accumulated rainfall** for the latest 10-day period



Project Information
[Data Processing](#)
[Data Access](#)
[Data set Validation](#)
[Documentation](#)
[References](#)
[Contacts](#)
[Acknowledgment](#)
[Disclaimer](#)
[Related Sites](#)

Introduction

The U.S. Department of Agriculture's Foreign Agricultural Service (USDA-FAS), in cooperation with the National Aeronautics and Space Administration's (NASA) Goddard Earth Sciences Data and Information Services Center (GES DISC), has been routinely using satellite-derived data to monitor precipitation around the world. A key feature of this project is its use of near-real time global satellite precipitation data in an operational manner. Satellite precipitation products are produced by NASA via a semi-automated process and made accessible from this Web site for USDA and public viewing. Monitoring precipitation for agriculturally important areas around the world greatly assists the USDA-FAS to quickly locate regional weather events, as well as improve crop production estimates.

Data Processing [Top](#)

The NASA Goddard Space Flight Center (GSFC) system to produce the "TRMM and Other Data" estimates in real time was developed to apply new concepts in merging quasi-global precipitation estimates and to take advantage of the increasing availability of input data sets in near real time. The overall system is referred to as the "Version 6 TRMM Real-Time Multi-Satellite Precipitation Analysis." For convenience, it is referred to here as the "TMPA-RT."

The TMPA-RT is run quasi-operationally on a best-effort basis at the NASA Precipitation Processing System (PPS, formerly the TRMM Science Data and Information System, TSDIS), with on-going scientific development by the research team led by Drs. Robert Adler and George Huffman in the GSFC Laboratory for Atmospheres. Estimates are posted to the Web about six hours after observation time, although processing issues may delay or prevent this schedule. Due to the experimental nature of these estimates, users are encouraged to report their experiences with the data, and they should expect episodic upgrades or outages as the system develops.

There are three "TRMM and Other Data" products: (1) 3B40RT (High Quality or HQ), which is a combination of all available TRMM, SSM/I, AMSR-E, and AMSU-B microwave precipitation estimates; (2) 3B41RT (Variable Rain-rate Infrared, or VAR) precipitation estimates from geostationary infrared (IR) observations using spatially and temporally varying calibration by the HQ; and (3) 3B42RT (HQ + VAR), which is a combination of 3B40RT (HQ) and 3B41RT (VAR). The current combination scheme is simple replacement, i.e., for each gridbox, the HQ value is used if available; otherwise, the VAR value is used. As a final step for the real-time system, the 3B42RT estimates

Projects with USDA



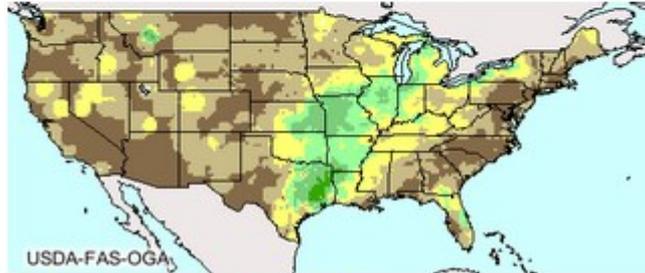
United States

2013 Summer Crop (Mar - Nov) — (Next Update on 11/11/2013)

AFWA/LIS Precipitation

10/21/2013 - 10/31/2013 [View in Google Earth](#)
[Previous 10-day](#)

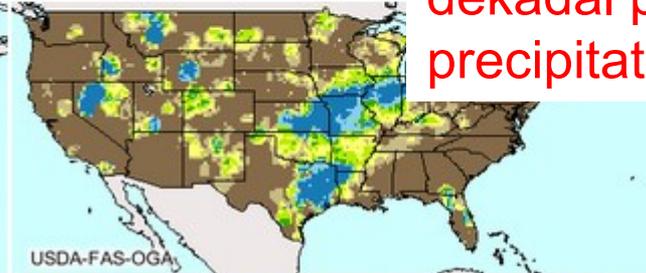
Click on a U.S. region to view its thematic map.



USDA-FAS-OGA

AFWA/LIS Dekadal Percent Normal Precipitation

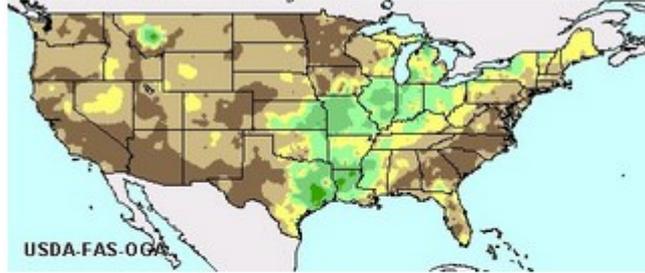
10/21/2013 - 10/31/2013 [View in Google Earth](#)



USDA-FAS-OGA

WMO Precipitation

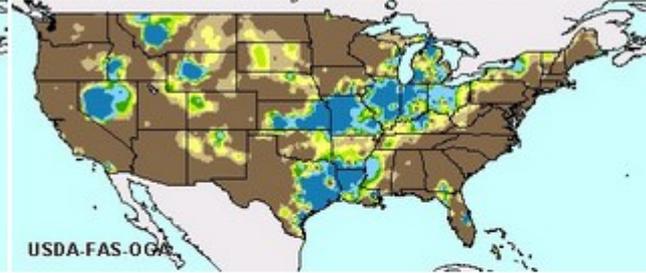
10/21/2013 - 10/31/2013 [View in Google Earth](#)



USDA-FAS-OGA

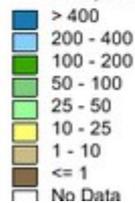
WMO Dekadal Percent Normal Precipitation

10/21/2013 - 10/31/2013 [View in Google Earth](#)



USDA-FAS-OGA

Precipitation (Millimeters)



Dekadal Percent of Normal (%)



TMPA precipitation and dekadal percent normal precipitation

Projects with USDA

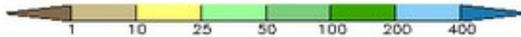
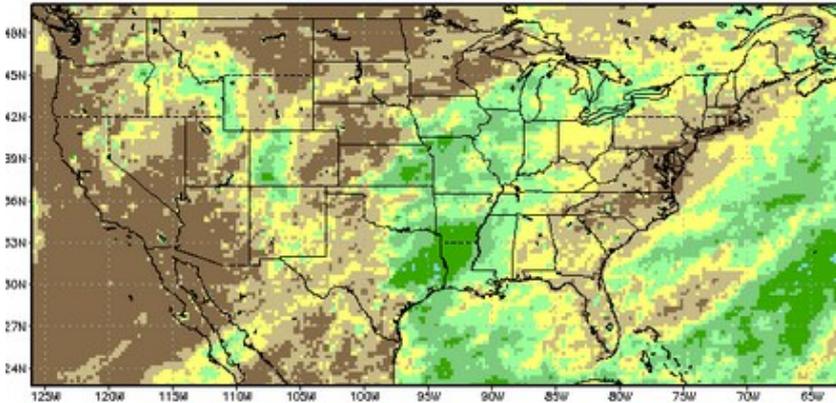
USDA FAS Crop Explorer & TMPA

USDA United States Department of Agriculture
Foreign Agricultural Service



[Home](#) | [Return to Previous Page](#) (Note: This is a Beta version)

TMPA-RT Precipitation [mm]
(21oct2013 - 31oct2013)

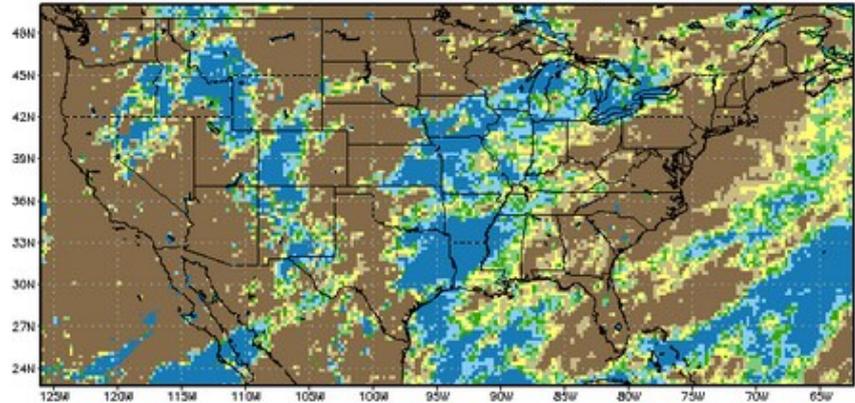


40S: 00LA/00ES

Generated by NASA's Giovanni (giovanni.gsfc.nasa.gov)

2013-11-07-1405 40S: 00LA/00ES

TMPA-RT Decadal Percent Normal Precipitation [%]
(21oct2013 - 31oct2013)

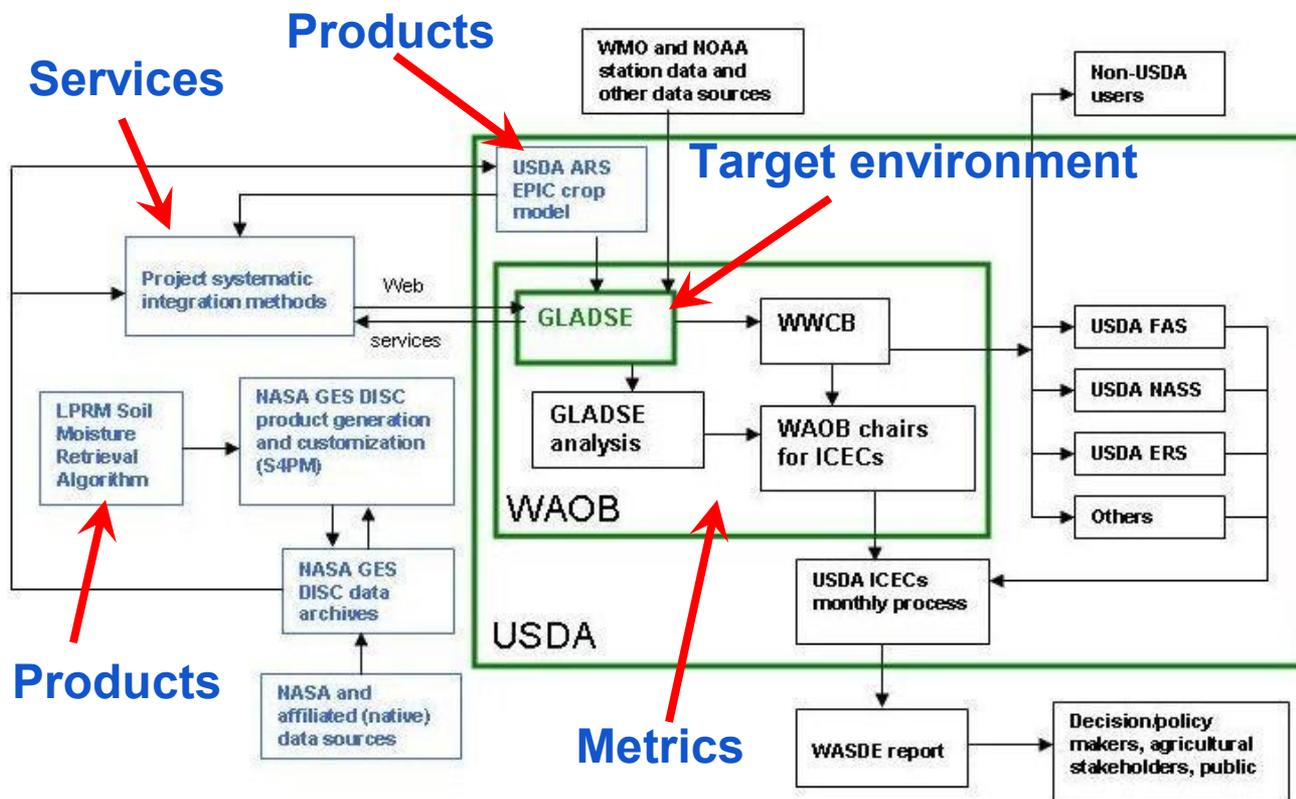


Generated by NASA's Giovanni (giovanni.gsfc.nasa.gov)

2013-11-07-1405



Overview

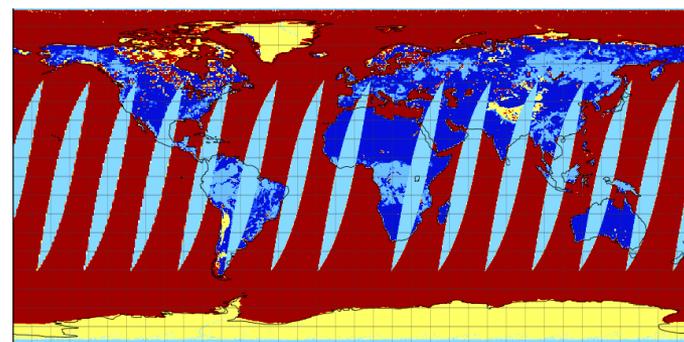
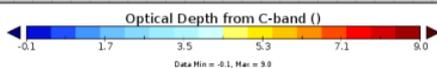
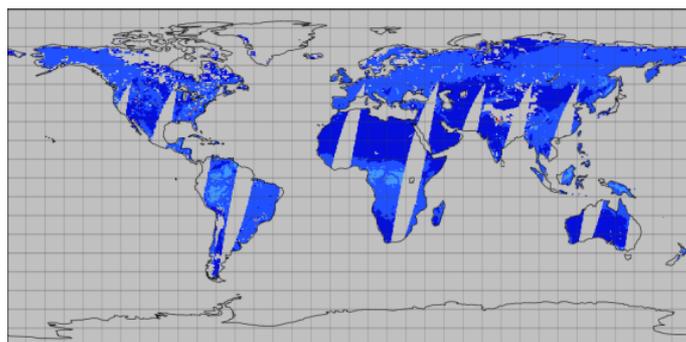
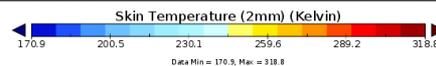
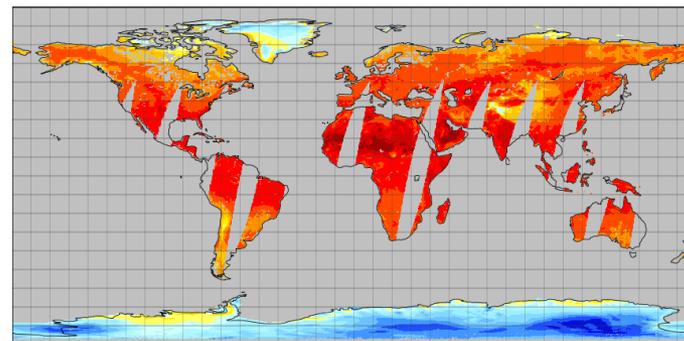
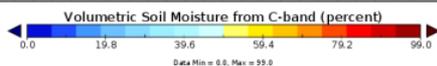
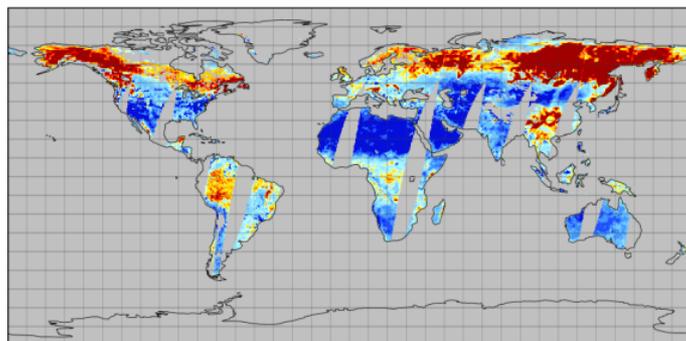


Operational flow of GLADSE and other USDA entities and of project components (in blue)



Projects with USDA

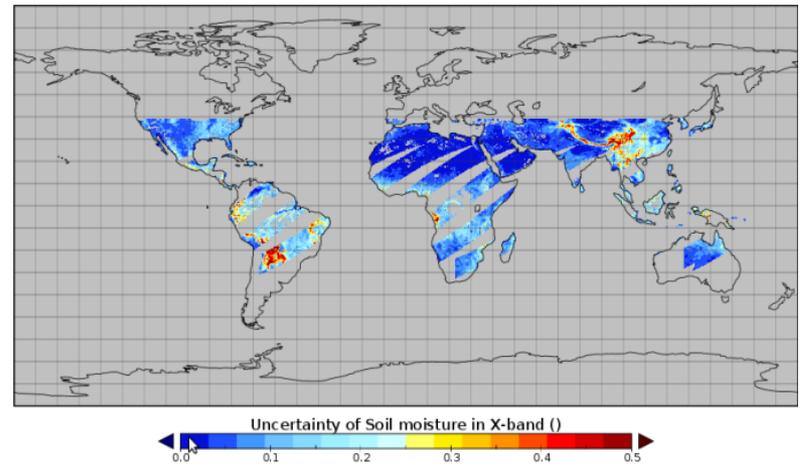
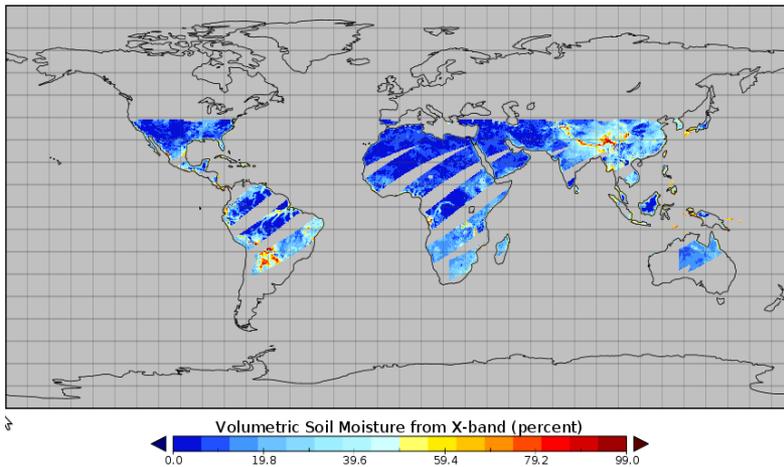
LPRM-AMSR-E Soil Moisture





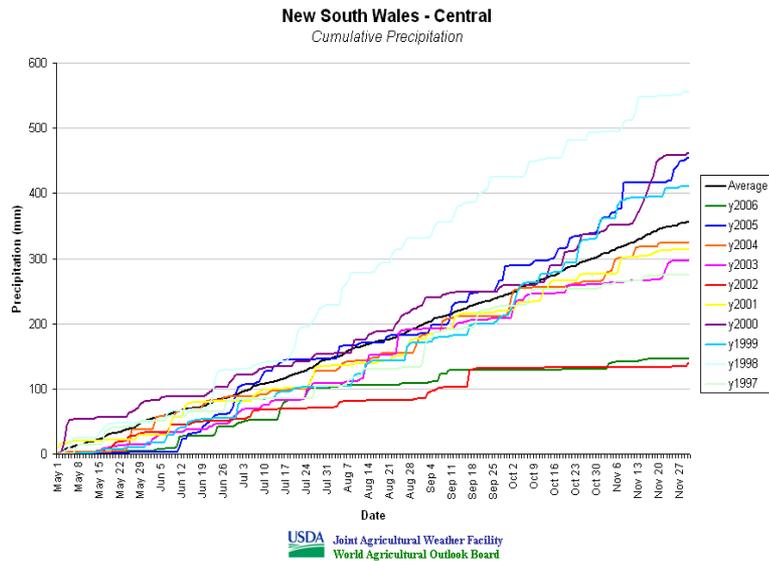
Projects with USDA

EOS/Aqua AMSR-E Loss and Mitigation (LPRM-TMI SM)

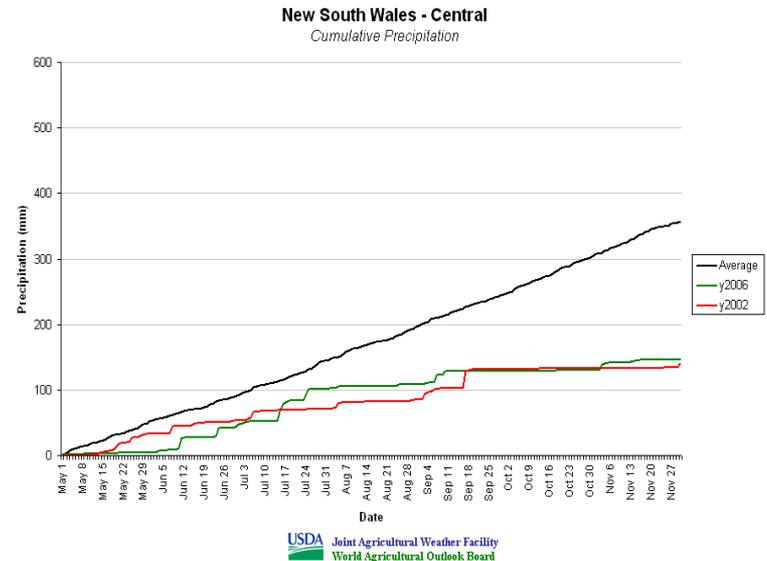




Benchmark and Metrics



2006 is the target year...
...what year(s) are similar?

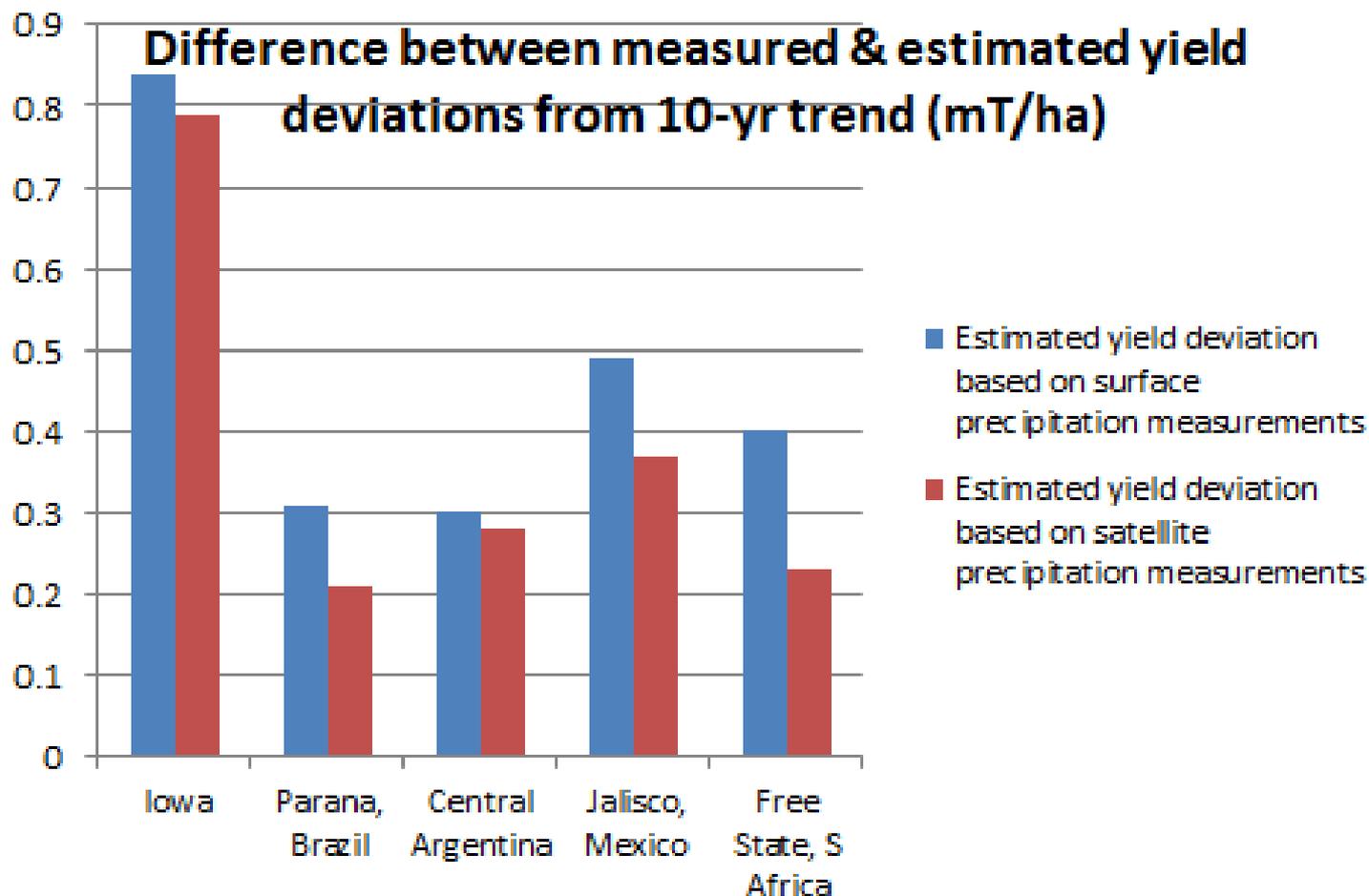


2006 is the target year...
... 2002 is an analog year.

Actual Δ winter wheat yields from trend (T/ha):
2006 -1.63; 2002 -1.38

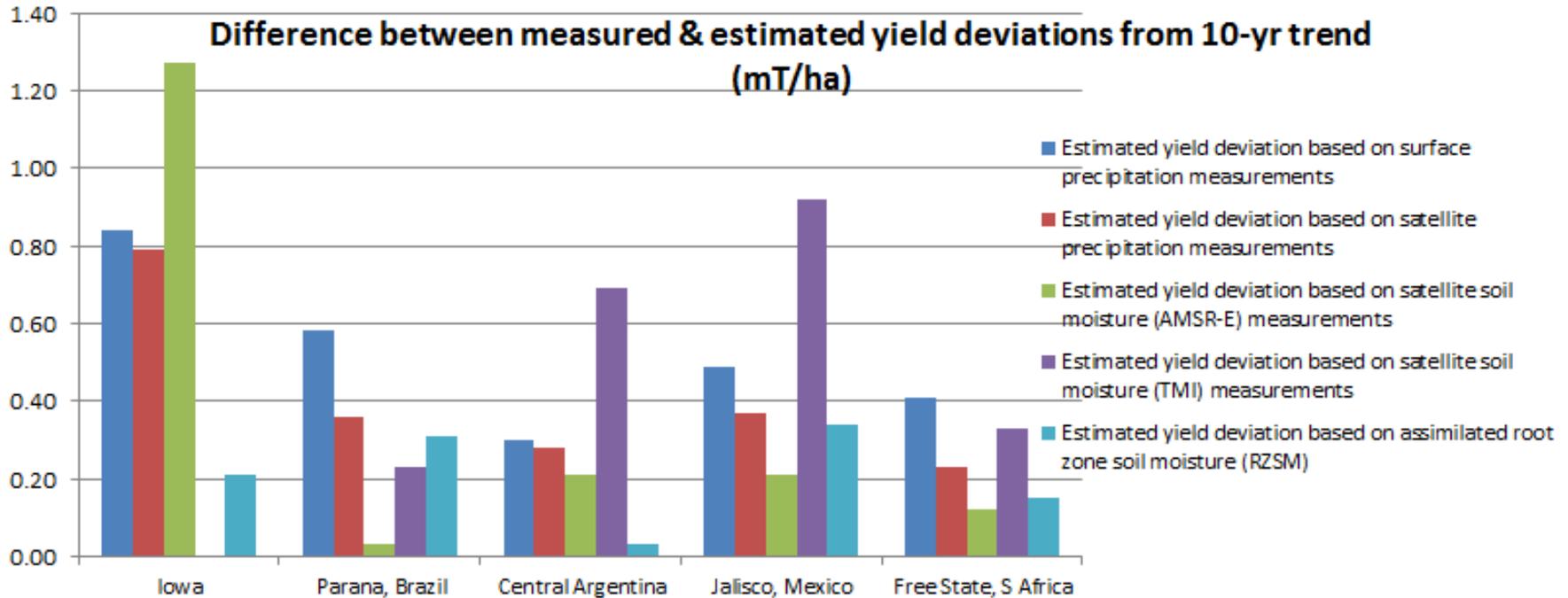


Projects with USDA





Projects with USDA





Toward Handing Off to WAOB and Making a Difference

- Live, operational, forward-processing satellite precipitation and soil moisture data products.
- Service options for accessing and integrating data products into GLADSE.
- Operational Giovanni portal.
- **Key result:** Crop yield estimates derived from satellite-based precipitation and soil moisture data are closer to measured yields than are estimates derived from surface-based precipitation measurements.
- **Establishing analog analysis methodology in station-rich areas; apply in station-poor areas of the world; significantly extend global coverage.**
- WAOB is focal point for economic intelligence within USDA. Improving WAOB's agricultural estimates (WASDE) will be significant for USDA and visibly demonstrate value of NASA resources for societal benefits.



Project with CUAHSI

Data Reorganization for Optimal Time Series Data Access, Analysis, and Visualization

Work supported by NASA ROSES NNH11ZDA001N-ACCESS



“Digital Divide” Problem

- **Data archived in the form of all variables one time step per file**
- **Users often need long time series for single variables at single grid “points”**
- **Access is orthogonal to archive → Inefficient**



Project with CUAHSI

NLDAS/GLDAS Data Files and Total Volume

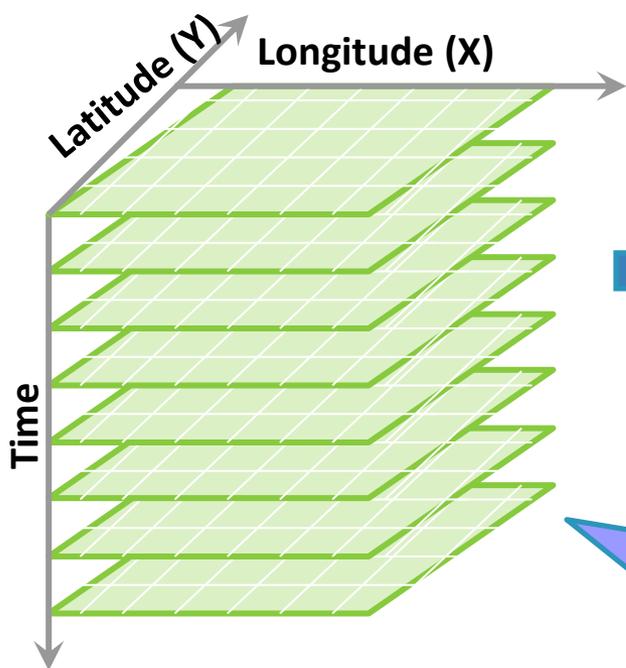
Data sets	Temporal		Spatial		Dim	Total grids	# Files per data set	Total vol
	Res	Cov	Res	Cov				
NLDAS	hourly	1979-present	0.125°	N. Amer	224x464	93542*	289080	~ 4.8 TB
GLDAS	3-hourly	1948-present	0.25°	Global	600x1440	259200*	96360	~ 1.6 TB

* Per parameter; reduced by NLDAS land ~ 0.9; GLDAS land ~ 0.3



ACCESS Project Solution for Bridging the Digital Divide

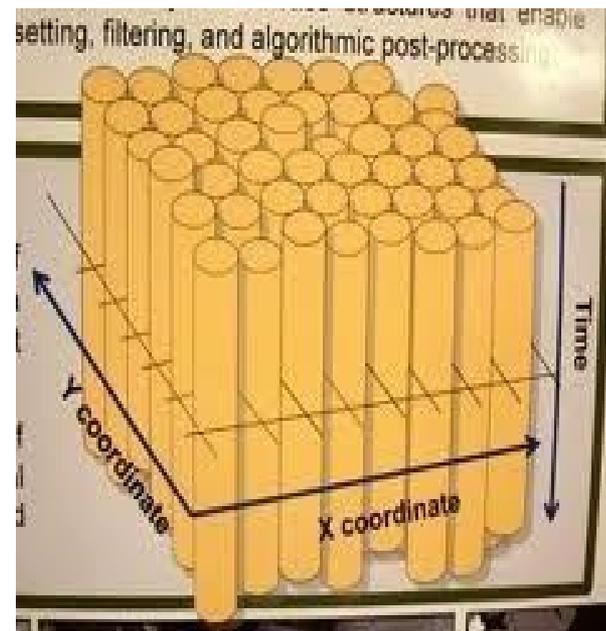
Original Data Archive



One variable
one grid point
all time steps
per file

All variables
all grid points
one time step
per file

Reorganized Data Archive



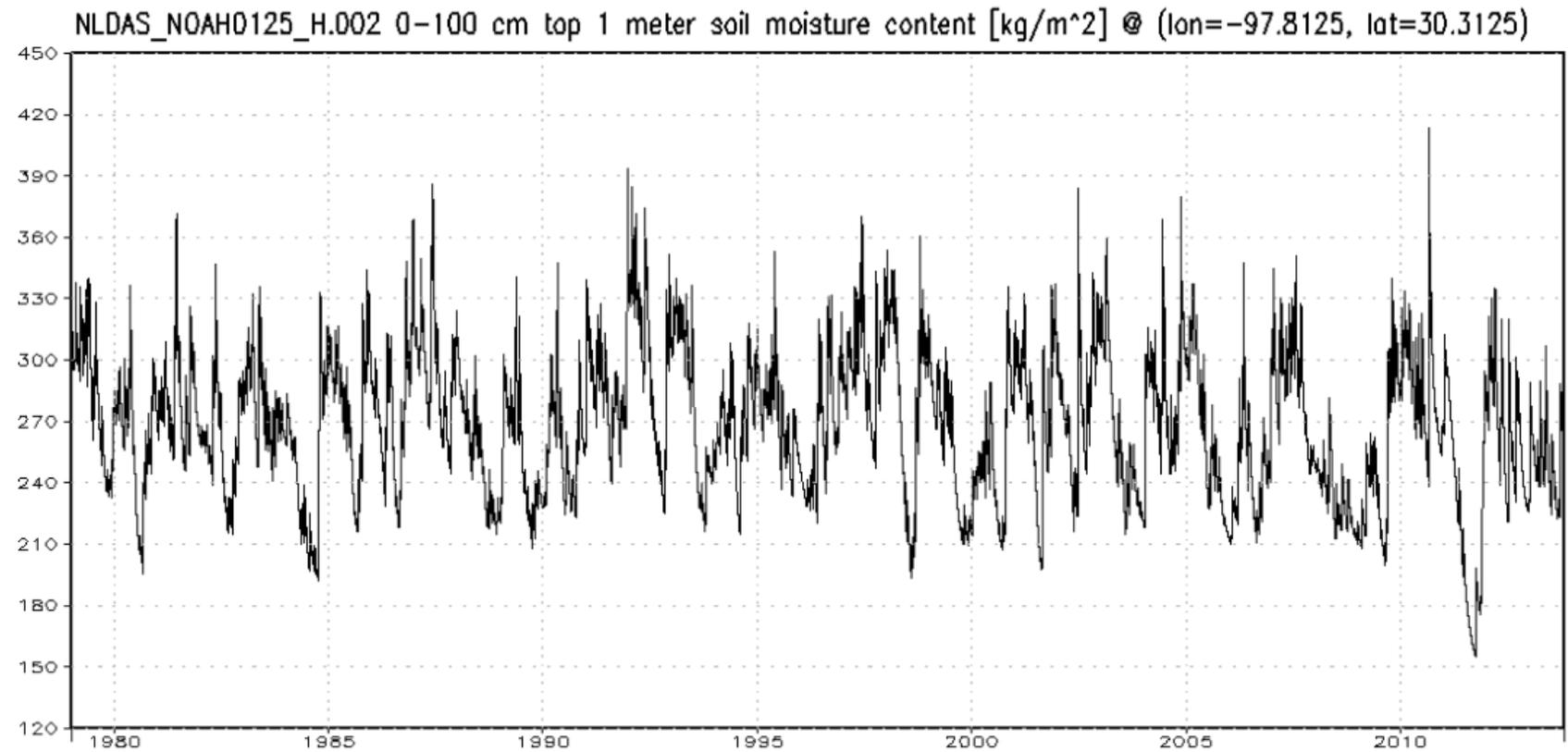


Early time series service of NLDAS Noah 0-100 cm soil moisture, e.g.,

http://hydro1.sci.gsfc.nasa.gov/daac-bin/access/timeseries.cgi?variable=NLDAS:NLDAS_NOAH0125_H.002:SOILM0-100cm&startDate=1979-01-02T00&endDate=2012-09-30T23&location=NLDAS:X217-Y042&type=plot



Project with CUAHSI



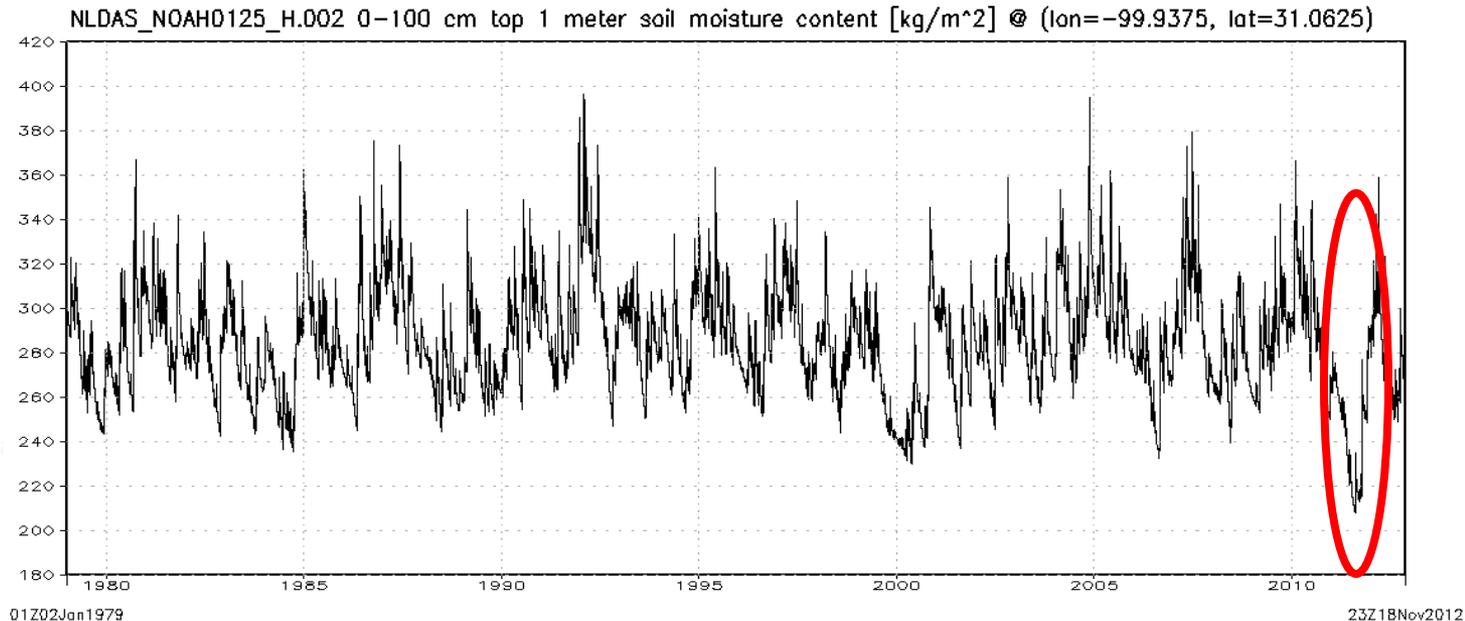
00Z02Jan1979

Generated 2013-11-07 13:37:22 GMT © NASA GES DISC

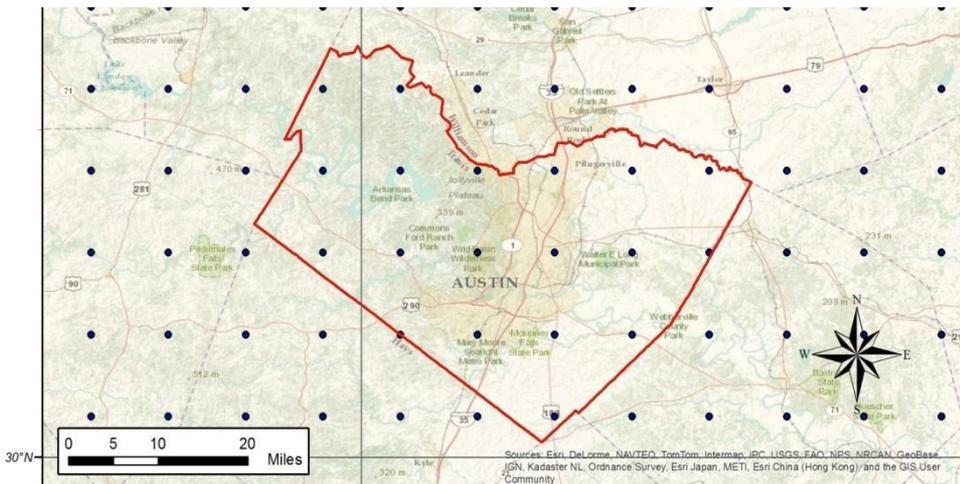
23Z31Oct2013



TNRIS* Use Case



Generated 2012-11-26 17:26:27 GMT © NASA GES DISC



***Texas Natural Resources Information System**



Project with CUAHSI

NLDAS parameters with time series access available (0.125° hourly, 1979-present)

Forcing

- **Precipitation hourly total**
- **2-m above ground temperature**
- **10-m above ground zonal wind speed**
- **10-m above ground meridional wind speed**
- **Potential evaporation**

Noah

- **0-100 cm top 1 meter soil moisture content**
- **0-10 cm soil temperature**
- **Surface runoff**
- **Total evapotranspiration**

GLDAS ..., TMPA, LPRM

MERRA ...

AIRS ...



Thank You



GES DISC:

<http://disc.gsfc.nasa.gov>

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